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**TIME-KEEPING BY LIGHT AND FIRE.**

BY WALTER HOUGH.

The wonderful progress in the minification of time and in the whole science of metrology has called increasing attention to the methods of primitive peoples and to the survivals among the civilized. There will soon be a sufficient body of observations to illustrate the early stages of the faculty of estimation and the devices which have grown out of the aggregates of experience.

An almost unnoticed fact in the history of time-keeping is the use of fire and light for measuring and checking time.

The first employment of time-checks based upon the steady consumption of combustible substances by fire is to mark off short periods, rather than to keep a continuous record of time. This is in accord with the appreciation of the value of time in the unrefined states of culture.

The observation of the heavenly bodies in a rough way, or the progress of a shadow in grass, or later the march of the shadow upon the dial, all growing out of planetary motion, seem often to have given place to the wasting of fire and the flowing of sand or water. The aid of fire becomes of value when it is desired to record the passage of a night, when the burning of a homogeneous, tinder-like branch, or a torch might give a fair estimate of the loss of time when the heavenly bodies were hidden.

Most of the Pacific Islanders burn torches of the oily nuts of the "candle-nut tree," *Aleurites triloba*, by skewering a number of the kernels on a long palm-leaf midrib and lighting the upper one. The kernels are of nearly uniform size, and burn with a clear bluish flame, consuming in about ten minutes to a fungus, which, when the nut below is ignited, must be removed by some one in attendance. The Marquesans tie bits of tapa at intervals along the torch, and thus have invented a clock.

In China there are many examples of a similar measurement of time. The prescribed time during which the royal procession at the coronation of the emperor must move through the distance between the palace and the temple is regulated by a functionary

who burns a "joss stick" (the traditional incense) of a certain fixed length.<sup>1</sup> At present in China *gong heung*, or time incense, consisting of five sticks made of pressed wood dust, long and short, according to the season, is burnt during the night, which is divided into five watches. A bundle of these sticks from Canton, presented by Stewart Culin, is in the U. S. National Museum; they are about one-quarter of an inch in diameter and 16 inches long.

"Professor Mason referred to a simple time-check used by Chinese physicians. It was a joss-stick broken so as to have several angles. The doctor set fire to one end and instructed his patient to take his first dose when the fire reached the first angle, another when it reached the second, and so on."<sup>2</sup>

In Western China, along the Yellow river, "the water is raised by immense wheels, generally fifty to sixty feet in diameter; they belong to villages and in a few cases to individuals, who, for a small consideration, sell the water to the peasants. The price is calculated by the quantity which flows from the wheel while a given length of joss-stick burns."<sup>3</sup>

Chinese messengers who have but a short period to sleep, awake themselves by putting a lighted bit of joss-stick between the toes. This acts as an alarm and stimulus at the proper moment.

In Korea, the regulation and recording of time is intrusted to certain petty officials, who tell the time by what is called the "dew clock," and which is probably a clepsydra. The night up to twelve o'clock is divided into five parts, *giung*, and these into five smaller, *jium*, which are announced by a drum and gong. At twelve o'clock the record ceases and the gates are opened. The palace clock is an oiled paper lantern, inclosing and screening from the wind a rope of hemp soaked in niter, called "fire rope," *hwa-sung*, which burns steadily. Each hour is divided into four parts by cords tied to the rope, and the latter is kept burning continuously. Time is announced by a lantern having transparent slides marked with the different *giung*, placed before the king's window. An officer takes charge of this clock, and the perpetuation of the custom seems due more to deference for tradition than for any practical purpose. It is probably of some value as a check upon the "dew clock." The Koreans also reckon time by the number of pipes smoked. Thus,

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<sup>1</sup> Douglas, China.

<sup>2</sup> The American Anthropologist, I, January, 1888, p. 49.

<sup>3</sup> W. W. Rockhill: The Land of the Lamas, p. 42.

you will hear them say, "He only stopped long enough to smoke one pipe."<sup>1</sup>

It seems probable that the idea of utilizing flame and fire for the purpose under consideration has occurred to minds in diverse periods and places. The candle-clock of King Alfred, by which time was reckoned through the wasting of measured candles shielded behind screens of horn, is well known, and marks an advance upon the former crude estimations. King Alfred's device seems to have been a more complete adaptation of the familiar use of a certain length of candle as a time-check.

Marked candles, "King Alfreds," can still be procured in England, where these are said to be used in Catholic churches. There is a pair in our National Museum, each divided into ten sections. During the Middle Ages, in France it was customary to divide the night period by means of candles. In the literature there are allusions to events happening at one, two, or three "candles of the night" (*chandelle de nuit*).

In the monasteries, also, when the stars were obscured the watchers chanted prayers or psalms of a known length to gauge the intervals elapsing.

The use of the candle time-check was widespread in Europe, and still survives in a few places. A late notice is found in the *Heilenkirchener Zeitung* of Aachen, Germany, for November 22, 1890, where tax sales are advertised of parcels of land to be sold "bei brennenden lichte." "Auction by candle" and "excommunication by candle" are well-known expressions, and even "courting by length of candle" is familiar. In the ancient Hungarian folk-tale "Prince Unexpected," the ogre Bony lights a straw and the Prince must stitch a pair of boots before it goes out or lose his life.<sup>2</sup>

In view of the antiquity of the candle, which was well known alike to the Romans and Norsemen, and presumably by the Egyptians and Babylonians, is it not probable that its value as a time indicator may have been observed and applied by these peoples? A cuneiform sign preserves the primitive fire-drill of the aboriginal Akkadians;<sup>3</sup> a similar clue with regard to time-keeping may link the Euphrates with the Hoang-ho.

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<sup>1</sup> Rockhill, *Laws and Customs of Korea*, Am. Anthropol., iv, 1891, p. 183.

<sup>2</sup> Folk-Lore Jour., ii, Jan.-Dec., 1881, p. 14.

<sup>3</sup> Aboriginal Fire-Making, Am. Anthropol., vol. III, 1890, p. 359.

A later development of the use of flame in time-keeping are the lamp-clocks in vogue in Europe up to the XVIII century. The specimens preserved in Cluny Museum consisted of an elongated upright reservoir, graduated into six or more divisions, and the wick-carrier resembled in shape the ancient gravy-bowl lamp. They were thought a success in spite of the number of causes which would render this time-keeping device inaccurate. There is some evidence as to when this lamp was invented: "En 1670, le père Lana (Ed. Fournier Le Vieux Neuf, t. I, p. 20) avait construit une lampe indiquant les heures, qui devait être analogue à l'appareil que nous venons de décrire."<sup>1</sup> The author cited describes a lamp of this character in his collection.

THE MEANS OF DISTINGUISHING JADEITE AND NEPHRITE BY SPECIFIC GRAVITY.—Professor Mason, in his review of my paper on jade (vol v, p. 246, July, 1892), says: "The author calls in question somewhat the conclusion of Clarke and Merrill that specific gravity is the best practical means of distinguishing jadeite and nephrite, but his tables (p. 40) show that all jadeites are above 3.27 and all nephrites not only below that, but generally 3 or less." This remark of Professor Mason can only have been made by oversight, as my tables prove just the contrary. I enumerate jadeites with a lower specific gravity from the following localities:

America, from Mexico to Brazil.....	2.87-3.11
Asia: Barma .....	2.97-3.07
France.....	3.16
New Guinea.....	3.06

Others could be added. Even chloromelanite, which is said to possess a specific gravity of 3.40-3.65 (Damour), occurs in New Guinea with 3.16. The statement of Clarke and Merrill (Pr. U. S. Nat. Mus., 1888, xi, 129), that "the only practical means of distinguishing between the two substances . . . would seem to be by their specific gravities," therefore by no means holds good. The microscopical and, in certain cases, even the chemical analysis must often be added, if one wishes to get a safe diagnosis. If one is not permitted to damage the object, a trustworthy diagnosis between jadeite and nephrite cannot be made at all. (Compare Arzruni's remarks: *Zeit. für Ethn.*, 1892, p. 32.)

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<sup>1</sup> Henry-René D'Allemagne, *Histoire de l'uminaire depuis l'époque romaine jusqu'au XIX siècle*. Paris, 1891, p. 283.